Memorandum

U.S. Department
of Transportation

**Federal Highway
Administration**

Subject: Discussion Paper on the Appropriate
Level of Highway Air Quality Analysis
for a CE, EA/FONSI, and EIS

Date: APR 7 1986

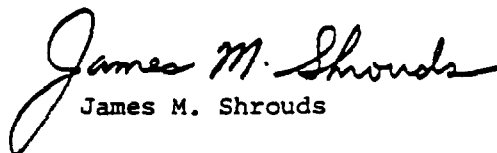From: Chief, Noise and Air Analysis Division
Washington, D.C. 20590

Reply to
Attn. of: HEV-30

To: Regional Federal Highway Administrators
Regions 1-10
Direct Federal Program Administrator

The attached discussion paper has been prepared as guidance material on the
appropriate level of air quality analysis needed for a highway project processed
with a Categorical Exclusion (CE), Finding of No Significant Impact (FONSI), or
Environmental Impact Statement (EIS). A sample project analysis using simplified
analysis techniques is also a part of the discussion paper.

The guidance contained in the paper is based on process reviews, training
courses, and technical assistance this office has conducted over the past
several years. The guidance is intended to make the air quality analyses
commensurate with the air quality issues associated with a particular project.
As stated in the text, however, this guidance should not be viewed as absolute,
since each State may differ in the agreements that State highway agencies and
State air quality agencies have developed.

Any questions on the attached discussion paper should be directed to
Richard Schoeneberg or Mark Stahr of my staff at 426-4836. Regional Offices
are encouraged to provide copies of the discussion paper to the Division Offices.

James M. Shrouds

Attachment

DISCUSSION PAPER

Appropriate Level of Highway Air Quality Analysis
for a CE, EA/FONSI, and EIS

Federal Highway Administration
Office of Environmental Policy
Noise and Air Analysis Division (HEV-30)

March 1986

PURPOSE

To provide guidance on the appropriate level of air quality analysis needed for a highway project processed with a Categorical Exclusion (CE), Finding of No Significant Impact (FONSI), or Environmental Impact Statement (EIS).

BACKGROUND

Both the Clean Air Act (CAA) and the National Environmental Policy Act (NEPA) require that air quality be considered in the preparation f environmental documents for any proposed project. The CAA also requires that all programs, plans, and projects conform to the State Implementation Plan (SIP) and that priority be given to implementing those portions of the plan that are to achieve and maintain the national primary ambient air quality standards (NAAQS). The Federal Highway Administration (FHWA) conformity and priority procedures are contained in 23 CFR 770.

The level of detail in an air quality analysis will vary considerably according to the size of the project, the existing level of air quality in the area, and degree of controversy. The only pollutants of concern for a project analysis are those that would be directly affected by the project.

The primary pollutant that is analyzed at the project stage is carbon monoxide (CO). Given the dramatic drop in average per vehicle CO emissions over the past 15 years, a vast majority of highway projects will not show a projected violation of the CO standards (35 parts per million over a 1-hour period or 9 parts per million over an 8-hour period). An appropriate level of analysis should be performed to assure that violations will not occur. If the analysis indicates that a violation of one of the CO standards will occur, consideration of appropriate mitigation measures should be included in the air quality analysis.

Ozone is not a concern at the project level, because it is an areawide pollutant which is analyzed in system-level planning as part of the SIP development process. Lead emissions were thought to be a concern in past years, but with the increasing use of unleaded gasoline and the lower levels of lead in leaded gasoline, lead standards are not expected to be violated in any project and need not be addressed in the environmental document. Particulate matter should not be a concern in regard to the new proposed small particulate "PM 10" standard (where only particles of 10 microns or smaller will be regulated), but may need to be addressed in regard to the control of dust from construction activities.

Air quality analyses vary considerably in content and level of detail from one project to another. There are several reasons for these variations. First, the FHWA guidance allows for considerable flexibility in performing these analyses. If the project-level analyses are undertaken, the scope, content, assumptions, and level of technical detail are typically coordinated between the State Highway Administration (SHA) and the State/local air quality control agency.

Second, air quality analyses are performed by different groups with varying levels of expertise. Some States rely heavily on consultants. Some States have centralized operations where all analyses are performed, and others have decentralized operations that vary in their technical capability to do project analyses. Therefore, it is not surprising to find variation in the content and quality of the work performed throughout the Nation.

Third, project location, local topography, and meteorological conditions influence the level of detail required. Large projects located in urban areas may require analyses that are quite detailed. Controversial projects involved in litigation, or which are otherwise challenged, are almost always analyzed in greater detail. Projects located in geographical areas with unique topography or adverse meteorology may also require a detailed investigation.

Fourth, a few States still have environmental laws such as Indirect Source Review (ISR), which require a permit before a highway can be constructed. These usually have an overriding influence on the scope, content, and level of detail of the analyses performed for EIS's. This is especially true when the SHA attempts to satisfy the ISR and EIS requirements with the same analysis. In some cases, the ISR permit is secured after EIS approval. A more elaborate analysis than the one performed for the EIS may be required to obtain a permit.

Fifth, in response to critical comments received from review agencies, additional or more detailed analyses are sometimes performed.

The following sections are intended to offer guidance on the appropriate level of air quality analysis for a project. Table 1 provides an overview of this guidance. This guidance should not be considered as absolute, since each State will differ in its relationship with air quality agencies and their agreement on how to treat projects. However, when SHA's develop or amend agreements with air quality agencies, these guidelines are recommended. Many agreements that have been made in the past were made during a period when motor vehicles had much higher emissions than current or projected emissions, and during a period when we knew less about pollutant dispersion characteristics.

AIR QUALITY ANALYSIS

1.   Categorical Exclusion

The CE's are projects which by definition do not involve significant environmental impacts. These types of projects typically have no affect on areawide air quality levels, but may provide some air quality benefits on a localized basis. As such, an air quality analysis is generally not necessary. If there is some question as to whether a particular project normally processed as a CE would have an air quality impact, this may be resolved by looking at previous analyses of similar projects or through a simplified analysis procedure, as described in the EIS section. If an analysis shows that the project will not create a new violation or exacerbate an existing violation of the CO standard, the project may be processed as a CE.

TABLE 1

LEVEL OF AIR QUALITY ANALYSIS

```
<----------CE---------------->- - - - - - - - - - - - - - ->
<--------------------------EA/FONSI---------------------->- - - - - - - - - - - - - - - - - - - - - - - - - - ->
<- - - - - - - - - - -<---------------------------EIS---------------------------------------------------------->
```

No analysis

Simplified analysis
-look-up tables for CO
 emission rates
-graphical solution
 for CO concentrations
-assume background levels
-include reasonable
 receptor site(s)
-conformity statement

Detailed analysis
 -"MOBILE" model for CO emission rates
 -CALINE3 or HIWAY2 line source models
  for CO concentrations
 -TEXIN or CALINE3 (with queuing considered) for intersection
  CO concentrations (special circumstances only)
 -background levels
  -assume or
  -model or
  -monitor
 -include reasonable receptor sites
 -consider appropriate mitigation measures
  if violations predicted
 -include evidence of coordination with EPA and
  State and local air quality agencies
 -conformity statement

LEGEND
 (-------) normal range
 (- - - -) possible range

3

127

2. Environmental Assessment (EA)/Finding of No Significant Impact (FONSI)

An EA/FONSI may also not need any analytical backup. Such a judgement could be based on previous analyses for similar projects or previous general analyses for various classes of projects. Low volume roads in rural areas would be an example of one class of project not normally requiring any analysis to make a judgement of air quality impacts.

If it is not certain whether or not there is an air quality impact, the procedures noted under the EIS section should be followed. In general, a simplified analysis procedure should be adequate for most projects processed with an EA/FONSI. However, if the predicted CO concentrations exceed the criteria noted under the EIS section, the analyst should make a more detailed analysis using computer modeling techniques.

For those projects where a CO microscale analysis is performed, the total CO concentration (project contribution, plus estimated background) at identified reasonable receptor sites (or a reasonable worst-case site if only one site is analyzed) for the preferred alternative should be reported and compared with applicable State and national standards. If the analysis shows that the project will not create a new violation or exacerbate an existing violation of the CO standards without abatement or if abatement is to be provided, that the abatement will prevent such impacts, the project may be processed with a FONSI.

3. Environmental Impact Statement

The air quality discussion in EIS's should normally include at least the results of a simplified CO analysis. Each alternative, including the no-build alternative, should be analyzed rather than only the preferred alternative. The total CO concentration at identified reasonable receptor sites for each alternative should be reported and compared with applicable State and national standards. Use of a table is recommended for this comparison for clarity. In most circumstances the "build" alternatives will show an improvement in air quality over the no-build, and this positive tone should be given to the writeup if this is the case.

A simplified analysis technique would normally consist of using look-up tables to estimate emission factors and a simplified dispersion technique, such as the use of nomographs, to estimate concentrations. A look-up table for vehicle emissions factors was transmitted to the field with FHWA Technical Advisory T 6640.10, "Mobile Source Emission Factor Tables for MOBILE 3," dated January 3, 1986. A simplified nomograph technique for estimating CO concentrations, titled "CALINE 3 – A Graphical Solution Procedure for Estimating Carbon Monoxide (CO) Concentrations Near Roadways," was distributed by FHWA Headquarters with Technical Advisory T 6640.6, dated March 2, 1981. An example using this technique, plus the emissions table look-up technique, is included at the end of this discussion paper.

If the results of the simplified emission/dispersion analysis show a
1-hour CO concentration of less than 15 parts per million (assuming a
meteorological persistence factor of 0.6), a more detailed analysis
should not be needed. An exception to this may be if the project is
located in an area where high traffic volumes or meteorological
stagnation conditions are expected over an 8-hour period of time. In
this case, or where the 1-hour CO concentration equals or exceeds
15 parts per million, a more detailed emissions analysis should be
performed. If a higher persistence factor is used, the corresponding
cutoff point for the use of a simplified analysis would be lower
(i.e., for a persistence factor of .7, a more detailed analysis should
be used if the 1-hour CO concentration equals or exceeds 13 parts per
million). A more detailed analysis would typically involve the
MOBILE 3/CALINE 3 computer model sequence, using mainframe or micro
computers.

If the above analyses predict a 1-hour CO concentration of less than
the 8-hour CO standard of 9 ppm, no separate 8-hour analysis is
necessary. In this case, the EIS should include a statement that
indicates that there will not be any violations of the 8-hour CO
standard since the worst 1-hour CO concentration is less than 9 ppm.
If the 1-hour CO concentration is equal to or greater than 9 ppm, an
8-hour analysis should be performed by multiplying the 8-hour average
traffic by a meteorological persistence factor (usually .6) and
dividing by the 1-hour traffic; then multiplying by the 1-hour CO
analysis concentration:

$$8\text{-hour CO conc.} = \frac{(0.6) \times (8\text{-hour average hourly traffic})}{(\text{peak-hour traffic})} \times (1\text{-hour CO conc.})$$

If no exceedence of the 8-hour standard is predicted, then usually no
further analysis is required. If an exceedence is predicted, then
eight separate 1-hour analyses should be performed and the results
averaged.

It should be noted that the 1-hour CO concentrations noted above
include both the background and project-related CO concentration
levels. Appropriate background concentrations can be estimated by
looking at monitored values from previous analyses, taking monitoring
data from State and local air quality agency monitors, or modeling
efforts. Monitoring data should be used with caution, since most
existing CO monitors are purposely located where violations occur or
are expected (usually due to traffic), and thus do not provide
realistic background levels. Project monitoring (for either background
or current project levels) should only be done when other data are not
available and the controversy or expected air quality impact of the
project warrant it. Consultation with State Air Quality agencies to
help determine appropriate background levels may be helpful. Except
in areas with unusual meteorological conditions, 1 ppm (rural) or
2-3 ppm (urban) would represent typical background levels.

For most projects, line-source analysis will be all that is needed.
On occasion, for controversial urban projects where a State air
quality agency has expressed concern, a CO intersection analysis may
need to be performed. To make an intersection analysis, more detailed
traffic data, such as turning movements and signal timing, will be
needed. An intersection analysis will be of little or no value if
detailed traffic are not available from traffic counts or model
predictions and have to be estimated.

Intersection analyses are also inherently less accurate than
line-source analyses, due to additional complexity in traffic
movements, emissions, and micro-scale meteorology. Some of the
techniques available are overly conservative to compensate for this.
The SHA should seriously consider whether an intersection analysis
will (1) provide useful information to decisionmakers, or (2) settle
the controversy surrounding the project before going through the
effort to perform one. If an analysis is performed, TEXIN
(distributed by FHWA) or CALINE 3 with consideration of queuing are
recommended. The EPA "Volume 9" procedures are not recommended since
they are cumbersome and costly to use, are based on obsolete model
formulations and substantially overpredict CO levels.

The receptors should be located where human activity is expected to
occur for the duration of time corresponding to the NAAQS for CO. If
a violation is indicated at a receptor, the analysis should include
consideration of appropriate mitigation strategies and the EIS should
include evidence of coordination with the Environmental Protection
Agency and State and local air quality agencies. Mitigation
strategies for air quality are limited, but generally any activity
which reduces congestion and increases speeds on the facility will
reduce CO concentrations. For urban intersections, this may involve
parking bans, changes in signal timing, etc.

4.   Conformity

In order for a project to conform to the SIP, it must (1) be a
Transportation Control Measure (TCM) from the SIP, (2) come from a
conforming Transportation Improvement Program (TIP), or (3) be exempt
from TIP requirements and not adversely affect the TCM's in the SIP.
These conformity requirements apply in air quality nonattainment and
maintenance areas where State and local officials have determined that
TCM's are required in the SIP to attain and maintain the NAAQS for
transportation-related pollutants. Conformity involves a comparison
of plans (i.e., SIP vs. TIP). The air quality analysis performed as
part of the environmental process is not required in order to
determine conformance. This is the difference between the CAA and the
NEPA — conformity is based on comparison, while the analysis for the
environmental document is a calculation of the anticipated pollutant
emissions, dispersion and resultant concentration in the vicinity of
the proposed project.

Simplified Air Quality Analysis

Example Problem

The project is an east-west link of a 4-lane urban at grade freeway, as shown in Figure 1. The lane width is 12 feet (3.7 meters) and there is a 30-foot (9.2 meter) median. The nearest receptor on this link is a home approximately 100 feet (30 meters) south of the centerline of the highway. From recent monitoring studies done in other parts of the city, it has been determined that the background level of carbon monoxide (CO) exclusive of roadway effects is 2 parts per million (ppm). The traffic forecasts indicate an average daily traffic (ADT) of 88,000, peak-hour travel of 7,480 vehicles per hour and an average hourly travel over the 8 continuous hours of highest travel of 5,610 vehicles per hour.

Find:

(a)   The vehicle emission factor for a predicted peak-hour speed of 21 mph, 20.6% cold starts, and 21° ambient temperature for 1985, and

(b)   The CO 1-hour and 8-hour concentrations at the receptor for meteorological stability class D and a 10° wind angle.

Determine Composite Emission Factor

Use the emission factor tables transmitted with Technical Advisory T 6640.10, "Mobile Source Emission Factor Tables for MOBILE 3," to determine the emission rates using the parameters noted above. The proper emission factor is circled on Table 2 of T 6640.10, which is reproduced on page 9. For a temperature of 20°, calendar year of 1985, percent cold start of 20.6, at low altitude, the single vehicle emission factor is 70 grams/mile. Note that the closest values for speed, temperature, and percent cold start have been used. It would have been possible, but unnecessary in this case, to interpolate within the range of the tabulated parameters.

Determine 1-hour and 8-hour CO concentrations

Step 1 - Determine 1-hour unadjusted CO concentration

Use the nomographs transmitted with Technical Advisory T 6640.6 to determine the unadjusted 1-hour CO concentration. For this problem, use the nomograph for Stability Class D (generally used in urban areas), and a wind angle of 10 degrees. Note that the chosen wind angle of 10° will normally result in the "worst case" concentration levels for any receptors reasonably close to the right-of-way line. For a receptor distance of 30 meters and an emission factor of 70 g/mi, the unadjusted CO concentration is 5.8 ppm. (See nomograph on page 10).
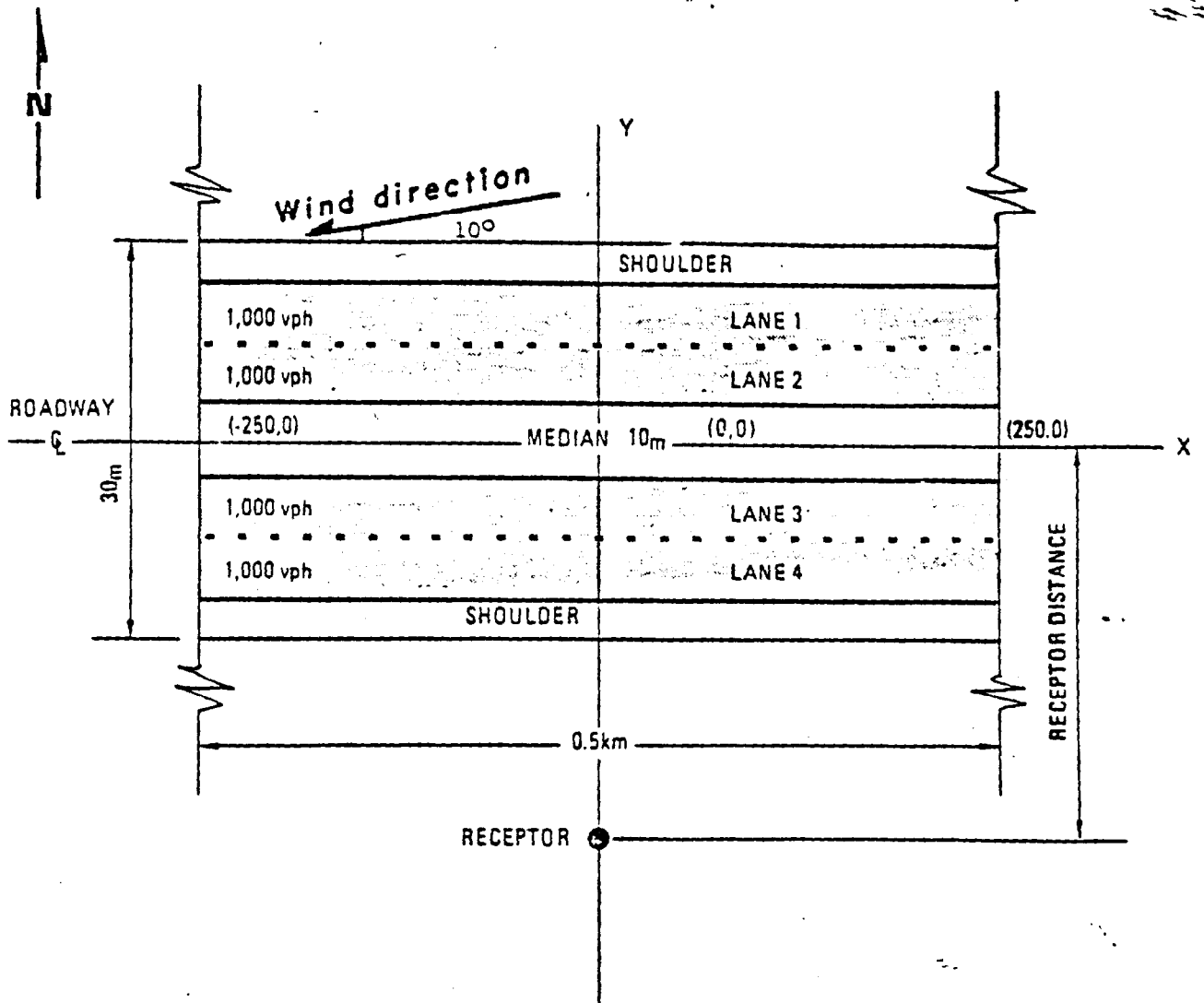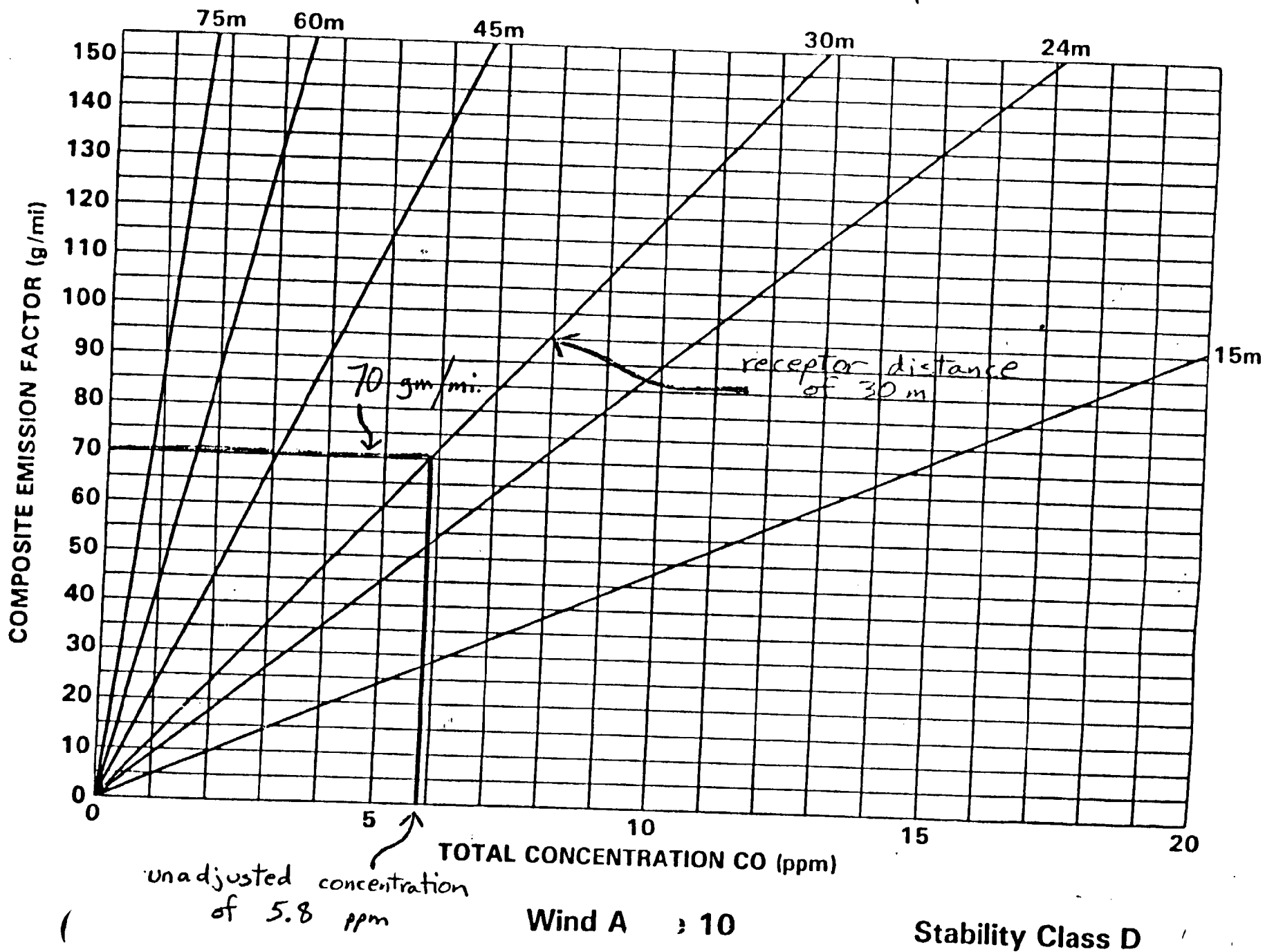
FIGURE 1: ROADWAY SECTION

TABLE 2
CO EMISSION FACTORS (GM/MI)
Low Altitude

PCCN = 20.6
PCHC = 27.3
PCCC = 20.6

TEMPERATURE (Degrees)	CALENDAR YEAR	Average Vehicle Speed (mph)						
		5	10	15	20	30	40	55
0	1985	276	167	121	94	60	41	29
	1987	234	149	111	87	55	37	25
	1990	184	129	98	77	49	32	20
	1995	140	108	85	68	43	28	16
	2000	125	99	79	63	41	26	14
	2005	122	97	77	62	40	26	14
10	1985	238	144	104	81	51	35	26
	1987	201	128	95	74	47	31	22
	1990	157	109	83	65	41	27	17
	1995	118	90	71	56	36	23	13
	2000	104	82	65	52	34	22	12
	2005	102	81	64	51	33	22	12
20	1985	208	125	90	70	45	31	23
	1987	173	110	81	64	40	27	19
	1990	134	93	71	55	35	23	15
	1995	99	76	60	47	30	20	11
	2000	87	69	55	44	28	18	10
	2005	85	67	53	43	28	18	10
30	1985	182	109	79	61	39	27	20
	1987	151	95	70	55	35	23	16
	1990	115	79	60	47	30	20	13
	1995	83	64	50	40	25	17	9
	2000	73	57	46	36	23	15	9
	2005	71	56	45	36	23	15	8
40	1985	161	96	69	53	34	24	18
	1987	132	83	61	47	30	20	15
	1990	99	68	51	40	25	17	11
	1995	70	53	42	33	21	14	8
	2000	61	48	38	30	19	13	7
	2005	59	46	37	29	19	12	7

Figure: Graph plotting COMPOSITE EMISSION FACTOR (g/mi) on the vertical axis (0 to 150) against TOTAL CONCENTRATION CO (ppm) on the horizontal axis (0 to 20), with receptor distance lines labeled 75m, 60m, 45m, 30m, 24m, and 15m.

Axis labels and annotations:
- Vertical axis: COMPOSITE EMISSION FACTOR (g/mi)
- Horizontal axis: TOTAL CONCENTRATION CO (ppm)
- 70 gm/mi.
- receptor distance of 30 m
- unadjusted concentration of 5.8 ppm
- Wind A ; 10
- Stability Class D

Step 2 - Adjust CO concentration for traffic volume

Since the nomograph is based on an assumption of 4,000 vehicles per hour, the CO concentration obtained from Step 1 must be adjusted for actual traffic conditions. Therefore, to obtain the adjusted concentration in ppm, multiply the CO concentration obtained from Step 1 by:

$$\frac{\text{actual traffic (vehicles/hour)}}{4,000 \text{ vehicles/hour}}$$

$$\text{actual traffic (vehicles/hour)} = 7,480 \text{ (vehicles/hour)}$$

$$\text{traffic adjustment factor} = \frac{7,480}{4,000} = 1.87$$

$$\text{adjusted CO} = 5.8 \text{ ppm} \times 1.87 = 10.8 \text{ ppm}$$

Step 3 - Determine total 1-hour CO concentration

$$\begin{aligned}
\text{Total 1-hour CO concentration} \\
= \text{Adjusted CO} + \text{background} \\
= 10.8 \text{ ppm} + 2 \text{ ppm} \\
= 12.8 \text{ ppm}
\end{aligned}$$

Step 4 - Determine total 8-hour CO concentration

If the 1-hour analysis predicts a 1-hour CO concentration of less than the 8-hour CO standard of 9 ppm, no separate 8-hour analysis is necessary. If the 1-hour CO concentration is equal to or greater than 9 ppm, an 8-hour analysis should be performed by multiplying the 8-hour average traffic by a meteorological persistence factor (usually .6) and dividing by the 1-hour traffic; then multiplying by the 1-hour CO analysis concentration:

8-hour CO concentration =

$$\frac{(0.6) \times (8\text{-hour average hourly traffic})}{(\text{peak hour traffic})} \times (1\text{-hour CO concentration})$$

Since the 1-hour CO prediction is above 9 ppm in this example, use of the above equation is called for.

8-hour CO concentration =

$$\frac{(0.6) \times (5610 \text{ vehicles/hour})}{(7480 \text{ vehicles/hour})} \times (12.8 \text{ ppm})$$

$$= 5.8 \text{ ppm}$$

In this example, project specific traffic data for the 8-hour period were available. In cases where such data are not available, a typical traffic persistence (8-hour average hourly traffic divided by peak-hour traffic) of .75 can generally be used, or the Tables in NCHRP Report 187, Chapter 6 may be used to compute a traffic persistence value.